GWOU ADMINISTRATIVE RECORD
SECTION TITLE:
GW-500-501-1.05

73206

STATE OF MISSOURI

Mel Carnahan, Governor • David A. Shorr, Director

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL QUALITY

P.O. Box 176 Jefferson City, MO 65102-0176

October 17, 1997

Stephen H. McCracken
U.S. Department of Energy
Weldon Spring Site Remedial Action Project
7295 Highway 94 South
St. Charles, MO 63304

Certified Mail / Return Receipt Requested
Receipt No. Z 289 840 576

Stephen K. Iverson
Kansas City District Corps of Engineers
Attn: MD-H
Room 647
601 E. 12th Street
Kansas City, MO 64106-2896

Certified Mail / Return Receipt Requested
Receipt No. Z 289 840 577

Dear Messrs. McCracken and Iverson:

We have reviewed the draft *Feasibility Study for Remedial Action for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri,* ("Feasibility Study" or "FS") and the draft *Proposed Plan for Remedial Action for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri* ("Proposed Plan" or "PP"). The FS and PP for the Groundwater Operable Units (GWOU) were prepared jointly by the U.S. Department of Energy (DOE), the Responsible Party (RP) for the Weldon Spring Chemical Plant (WSCP), and the U.S. Department of the Army (DA), the RP for the Weldon Spring Ordnance Works (WSOW).

The selection of Alternative 2, Monitoring with No Active Remediation, as the Preferred Alternative is unacceptable. The evaluation of remedial alternatives described in the Feasibility Study is superficial and, as presented, does not support either Alternative 2 or Alternative 3, Natural Attenuation. Rather, the evaluation seems merely an attempt to justify the alternative preferred by DOE and DA without regard for the merits.

Remedial alternatives which are protective of human health do not even survive preliminary screening, but an alternative which is not protective is selected as the preferred alternative. The overall approach of the evaluation is "all or nothing," i.e., any remedial alternative which involves more expense than mere monitoring or which cannot cleanup all contaminants throughout the entire aquifer is screened out. The need for a Technical Impracticability waiver is suggested, but no details on the scope of the waiver are given, and the technical justification is flawed and incomplete.

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Major issues with the FS and PP are described below. A more detailed list of comments is attached.

1. No Active Remediation *v.* Natural Attenuation. The "Monitoring with No Active Remediation" alternative relies upon the "groundwater's natural ability to lower contaminant concentrations through physical, chemical, and biological processes until cleanup levels were met." FS, p. 3-5. It is unclear how this should differ from Alternative 3, Natural Attenuation, which relies on "natural subsurface processes to reduce contaminant concentrations to acceptable levels." FS, p. 3-12. Even Alternative 1, No Action, takes credit for "natural processes — including reduction of nitroaromatic compounds and TCE by biodegradation and sorption; and attenuation of the uranium by decay [Note: The half-life of Uranium-238 is 4.5 billion years!], sorption, precipitation, and dilution." FS, p. 3-40.

   The technical protocol to support natural attenuation requires extensive data collection and analysis before and during implementation to demonstrate the effectiveness of natural processes to reduce groundwater contamination to acceptable levels. In discussions on the Quarry Residuals Operable Unit (QROU) FS, the authors of that document (who also authored the GWOU FS) confess that they deliberately use the term "No Active Remediation" in an attempt to avoid the requirements which would attach if the remedy were described as "Natural Attenuation." The authors attempt here to evade the technical requirements of the natural attenuation remedy is improper and unacceptable.

2. Reasonable maximum exposure scenario. The risk-based Preliminary Remediation Goals (PRGs) are correctly based on 10^{-6} risk of excess cancers as the point of departure. However, the reasonable maximum exposure (RME) scenario is incorrectly determined to be recreational instead of residential. The proposed PRGs based on the *recreational visitor* exposure scenario are approximately 100 times the values for the residential scenario. DOE and DA justify their "belief" in the recreational visitor scenario by ignoring the surrounding properties ("It is unlikely that the shallow aquifer *beneath the WSCP and the WSOW* would be used by a future resident." FS, p. 1-20, emphasis added.) or by appealing to unspecified "county zoning requirements for future housing developments" and a limited sample of municipal building permits and new well construction.

   Affected groundwater is not limited to that directly beneath the WSCP and WSOW; contamination from the WSCP and WSOW has migrated offsite. DOE has already determined that the affected aquifer is a Class IIA aquifer currently used for drinking water. "[I]n St. Charles County, the shallow and middle aquifers are also used, mainly for rural domestic water supply." FS, p. 1-11; PP, p. 9. More than 60 private wells in the vicinity of the Weldon Spring Site are on record, and at least 31 of these have been confirmed. The GWOU *Remedial Investigation* (at p. 1-10) mentions 45 wells "on or very near to the ordnance works area" some of which are "open to the shallow aquifer."

3. Preliminary remediation goal for nitroaromatics. The Feasibility Study incorrectly proposes risk-based PRGs for all nitroaromatic compounds even though Missouri water quality standards exist for three nitroaromatic compounds (nitrobenzene; 2-4, DNT; and 1,3-DNB). The proposed PRGs for these three compounds are approximately 100 to more than 1000 times the corresponding water quality standard.

   PRGs are to be set to health-based ARARs (e.g., water quality standards) when available. Risk-based values are appropriate only when ARARs are not available or are not sufficiently protective due to multiple exposures or multiple contaminants. The PRGs for nitrobenzene; 2-4, DNT; and 1,3-DNB should be set to the corresponding Missouri water quality standards. If consistency is desired, then PRGs for nitroaromatic compounds without ARARs should be set at levels commensurate with available health-based ARARs.

4. Preliminary remediation goal for nitrate. The proposed PRG for nitrate as nitrogen (Nitrate-N) is correctly set to the corresponding Maximum Contaminant Level (MCL). However, in accordance with 40 CFR 141.62, the proper MCL for nitrate is 10 milligrams per liter (mg/l) rather than 20 mg/l as proposed in the FS. The 20 mg/l level is justified (the correct citation is 40 CFR 141.11) with the statement "noncommunity water systems can use a level of 20 mg/L for nitrate if the water is not available to children under six months of age *and if other conditions are met.*" (Emphasis added.) Among the "other conditions" conspicuously omitted are that the 20 mg/l level is allowed *at the discretion of the State* and that no adverse health effects shall result.

   The State of Missouri has not agreed to an MCL for nitrate of 20 mg/l, and the FS presents no evidence that water is not available to children under the age of six months or pregnant and nursing mothers. DOE shall submit for review by the State of Missouri information regarding the populations to whom the groundwater is available. Until the State of Missouri approves a higher level, the appropriate MCL for nitrate is 10 mg/l.

5. Preliminary remediation goals for other contaminants of concern. The *Remedial Investigation* for the GWOU identifies the following as "site contaminants": lithium, molybdenum, uranium, nitrate, chloride, sulfate, nitroaromatic compounds, TCE and 1,2-DCE (1,2-dichloroethylene). PRGs are not proposed for lithium, molybdenum, chloride, sulfate, or 1,2-DCE.

6. Point of compliance. The Feasibility Study does not specify how remediation performance levels are determined. For groundwater, remediation levels should be attained throughout the contaminated plume, or at and beyond the edge of the waste management area.

7. Technical impracticability. The basis for granting a Technical Impracticability (TI) waiver (FS, pp. 3-9, 3-17; PP, p. 31) is inadequate. A TI waiver is intended when compliance

with an ARAR is not technically practicable from an engineering perspective with cost generally not a major factor unless compliance would be inordinately costly.

The FS or PP should clearly identify the ARARs or cleanup standards for which the TI waiver is sought and the areas over which the TI waiver will apply. Adequate site characterization data must be presented to demonstrate, not only that a constraint exists which could limit the ability to restore an aquifer, but also that the effect of the constraint on contaminant distribution and recovery potential poses a critical limitation to the effectiveness of available technologies. The TI waiver should be granted only after interim or full-scale aquifer remediation systems are implemented because often it is difficult to predict the effectiveness of remedies based on limited site characterization data alone.

8. Institutional controls. Alternative 2, Monitoring with No Active Remediation, relies exclusively on institutional controls. Institutional controls should not substitute for active response measures as the sole remedy unless such measures that actually reduce, minimize, or eliminate contamination are not practicable. Treatment and permanent remedies are preferred over simply preventing exposures through legal controls. Institutional controls are a necessary supplement when waste is left in place, when there is no practicable way to actively remediate a site, or when they are the only means available to protect human health.

DOE and DA have not yet demonstrated that active remediation is impracticable or that institutional controls are the only means available to protect human health. Without first exhausting all practicable active measures, it is inappropriate for the DOE and DA to attempt to shift to innocent parties (including private landowners) the burden of preventing exposures to contamination and the cost of damaged natural resources.

9. TCE contamination crossing the groundwater divide. "The areal extent of TCE contamination at the site extends from east of Raffinate Pit 3 to the south and southeast of Raffinate Pit 4." FS, p. 1-18. Assuming, as suggested by DOE, that the raffinate pits are the source of the TCE, contamination has apparently flowed south, *toward* the groundwater divide (See FS, Figure 3.7, p. 3-34.). This behavior is not completely inexplicable since TCE, which is denser than water, could migrate against the flow of groundwater. We reiterate our comment made during our review of the GWOU *Remedial Investigation*: What investigation has been made of TCE migration south across the groundwater divide?

Comments of Mr. James P. Fry, Missouri Department of Conservation, on the draft FS and PP are attached herewith and incorporated herein.

73206

We suggest carrying more alternatives through to the detailed analysis phase of the FS. Greater consideration should be given to alternatives with the potential for effective application localized areas of contamination, e.g., TCE contamination near the raffinate pits. In accordance with EPA guidance, do not screen out alternatives for cost unless the cost of the alternative is *grossly excessive* compared to the effectiveness it provides. Clearly identify and attempt to quantify uncertainties in the analysis; describe additional studies or further tests which could reduce the uncertainties.

We look forward to working with you to resolve these issues. Please contact Glenn A. Carlson, P.E., at the MDNR Weldon Spring Field Office (314-441-8030) if you have any questions about our comments.

Sincerely,

HAZARDOUS WASTE PROGRAM

Larry V. Erickson

Larry V. Erickson, P.E.
Chief, DOE Unit

Attachment

cc: Weldon Spring Citizens Commission
Joe R. Nichols, St. Charles County Water Department
Dan Wall, EPA Region VII
Tom Lorenz, EPA Region VII
Shelley Woods, State of Missouri Office of the Attorney General
Ron Robinson, Weldon Spring Ordnance Works Restoration Advisory Board

73206

Attachment 1

Comments on the
Draft *Feasibility Study for Remedial Action for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri*, and the Draft *Proposed Plan for Remedial Action for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri.*

1. Page 1-16. DOE cites building permit records only to support its "belief" that use of groundwater for residential purposes in the vicinity of the Weldon Spring Site "might be limited." However, DOE has determined that groundwater both north and south of the groundwater divide is currently used for drinking water (i.e., Class IIA groundwater). *Groundwater Classification for the Weldon Spring Site Remedial Action Project, Weldon Spring, Missouri*, DOE/OR/21548-116, April 1990. A United States Geological Survey (USGS) water well database contains information on 25 private water wells north and 15 private water wells south of the groundwater divide. The St. Charles Countians Against Hazardous Waste identified 17 private water wells not already identified by the USGS north of the groundwater divide in the vicinity of the Weldon Spring Site. Missouri Division of Geology and Land Survey has records on at least 16 water wells in the vicinity of the Weldon Spring Site between Dardenne Creek and the groundwater divide; two of these were reconstructed in 1989 and one was reconstructed in 1990. EPA believes that "Superfund remedies need to be protective of all individuals exposed through likely exposure pathways, not just large populations." 55 Federal Register (FR) 8713, March 8, 1990.

2. Page 3-39. DOE performs "a general cost analysis. . .to identify alternatives that are significantly more expensive than other alternatives that achieve the same level of risk reduction" and screens out alternatives which is "clearly an order-of-magnitude more expensive than other alternatives that provide the same apparent degree of protection." DOE misstates the role of cost in screening alternatives. "Alternatives may be screened on costs in two ways. First, an alternative whose cost is *grossly excessive* compared to the effectiveness it provides may be eliminated in screening. Second, if two or more alternatives provide similar levels of effectiveness and implementability *using a similar method of treatment or engineering control*, the more expensive may be eliminated from further consideration." 55 FR 8715, March 8, 1990, emphasis added.

3. Point of compliance. "If ground water can be used for drinking water, CERCLA remedies should, where practicable, restore the ground water to such levels." 55 FR 8753, March 8, 1990. "EPA believes that remediation levels should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area, when the waste is left in place." 55 FR 8753, March 8, 1990.

4. Bioremediation of TCE or nitroaromatics in groundwater is rejected on the basis of implementability "due to the low permeability of the aquifer." FS, p. 2-13. However,

TCE might be amenable to remediation by air stripping because "[t]he plume is located near one of the regions of highest permeability in the area." FS, p. 2-15. Vertical wells were retained "as potentially applicable to removing groundwater in limited areas at the WSCP where the permeability of the aquifer is highest." FS, p. 2-18. Horizontal wells are retained "as potentially applicable to removing groundwater in regions of higher permeability at the WSCP." *Ibid.* However, the summary in Table 2.3 does not mention even this "limited" applicability of vertical and horizontal wells.

5. Pages 3-6 through 3-9. The paragraph "Large Volume, Long Duration Release" ignores the fact that all contaminants are not found throughout the affected aquifer. For example, while the extent of TCE contamination is considerable, it is much more limited than nitrate contamination. The paragraph "Large Volume of Contaminated Media" also ignores the fact that all contaminants are not found throughout the affected aquifer. The paragraph "Contaminants Low in Volatility" does not include TCE which does not have a low volatility. The paragraph "Contaminants Located at Great Depth" also ignores the fact that all contamination is not found throughout the affected aquifer, and depths ranging from 10 to 185 feet are not "great depths." The issue is contaminant depths, not depth or thickness of a stratigraphic unit, nor the screened interval of a well.

6. The calculations and input values used to determine the risk-based PRGs should be included in the FS as an appendix. Statements that "[a]ssumptions and methodologies were *similar* to those used for risk estimate in the BRA" are not sufficient. FS, p. 1-27, emphasis added.

7. "Where the aggregate risk of [multiple] contaminants based on existing ARARs exceeds 10^{-4} or where remediation goals are not determined by ARARs, EPA uses 10^{-6} as a point of departure for establishing preliminary remediation goals." 55 FR 8718, March 8, 1990. Demonstrate that the aggregate risk of multiple contaminants based on existing ARARs does not exceed 10^{-4}. If aggregate risk exceeds 10^{-4}, recalculate PRGs to comply with 10^{-6} point of departure.

8. Alternative 4 (which removes and treats the groundwater) should be reconsidered in conjunction with the continued use of the Site Water Treatment Plant and the Quarry Water Treatment Plant. This would substantially reduce the costs to implement Alternative 4 through the use of existing facilities, plus utilize established processes.

9. The documents named above do not bear the seal of a geologist who is registered in the State of Missouri. The documents incorporate or are based on a geologic study or on geologic data that had a bearing on conclusions or recommendations reached after January 1, 1997. The Missouri Board of Geologist Registration (the "Board") is charged with the enforcement of the Missouri Geologist Registration Law that includes the

requirement that geologic work where public health, safety or welfare are at risk or potentially at risk be completed by or under the direct supervision of a geologist registered in Missouri. These comments convey no endorsement as to the validity of the work being completed in accordance with the Missouri Geologist Registration Law or the Board of Geologist Registration. Further, the GWOU FS and PP are not complete until properly sealed/stamped by a geologist registered in Missouri in accordance with the law and the rules as administered by the Board.

10. Alternative 2, Monitoring with No Active Remediation, is proposed as the preferred alternative, in part because "active remedial measures do not appear to significantly speed remediation time frames." However, definitive remediation time frames have not been provided for any of the eight preliminary alternatives. If remediation time frames are to be used as justification for the selection of Alternative 2, substantiating data should be provided.

11. Of the five active preliminary alternatives presented, three (Alternatives 6, 7, and 8) were omitted from further consideration due to incorporation of immature technologies. The remaining two alternatives (Alternatives 4 and 5) were omitted from further consideration due to restoration time frames in excess of 100 years. However, Alternatives 4 and 5 were designed to address all contaminants of concern across the entire WSCP/WSOW area, whereas Alternatives 7 and 8 were designed to address only the TCE-contaminated areas. Alternatives which utilize proven technologies to address only the TCE-contaminated areas should also be evaluated.

12. FS, Section 1.1.2.2, Geology, p. 1-8, Paragraph 5. According to the report, "Although some voids occur in the uppermost bedrock, they are generally isolated and display limited vertical or lateral continuity (Garstang 1991)." It should be noted that, although the voids in the Weldon Spring area may be considered to be isolated and to display limited vertical or lateral continuity for the purpose of determining collapse potential for a disposal cell, the same voids may provide significant contaminant migration pathways. Supporting evidence for this statement is presented in the following portions of the FS:

<u>Page 1-12, Paragraph 2</u>: "Water tracing tests provide additional evidence for the presence of a conduit system . . . "

<u>Page 2-8, Paragraph 3</u>: " . . . channeling of the groundwater flow in natural conduits in the shallow aquifer within the Burlington-Keokuk Limestone could not be effectively controlled (because of high hydraulic pressures in localized areas)."

<u>Page 3-8, Bullet 3</u>: "[The shallow bedrock aquifer] is conceptualized to be a diffuse flow system where the bedrock is thinly bedded or fractured sufficiently to serve as a uniform

porous medium, with superimposed conduit flow in large isolated fractures. Water movement in the shallow aquifer has been affected by karst development from solution activity in the carbonate bedrock."

Page 3-9, Bullet 2: "Two regimes of groundwater flow are postulated to exist in the shallow bedrock aquifer at the WSCP and WSCP (sic): diffuse flow and turbulent flow. Diffuse flow follows Darcy's law for a porous medium, but the high-velocity turbulent flow that occurs in conduits and in large, isolated fractures does not. Thus, the travel time from the shallow bedrock aquifer to an associated discharge spring can be on the order of only 5 to 8 hours."

Page 3-10, Paragraph 2: "Several natural underground conduits exist across the WSCP and WSOW where the groundwater travel time to surface springs is on the order of hours."

13. FS, Section 1.1.2.2 Hydrogeology, p. 1-12, Paragraph 2. According to the text, the presence of a conduit system is inferred by a groundwater trough in the contoured water table surface south of Burgermeister Spring. There are actually two groundwater troughs indicated on Figure 1.5, one in the northeast part of the WSTA, and one in the northern part of Chemical Plant.

14. FS, Section 1.1.2.2 Hydrogeology, p. 1-12, Paragraph 3. Please clarify the statement that groundwater flow "stays within its surface drainage."

15. FS, Section 1.1.2.2, Hydrogeology, p. 1-12, Paragraph 4. The text states that groundwater to the south of the groundwater divide flows south to southeast toward the Missouri River, primarily through the 5300 drainage. Please provide evidence that groundwater south of the divide flows "primarily through the 5300 drainage."

16. FS, Figure 1.5, Hydraulic Head Distribution in the Shallow Groundwater, p. 1-13. The date of the water level measurements used to construct this potentiometric map should be provided.

17. FS, Section 1.1.2.5, Land Use, p. 1-16, Paragraph 4. The text states that "County zoning requirements for future housing developments in the area around the WSCP and the WSOW preclude the need for well water for residential use." Please explain whether these county zoning requirements prevent individuals from drilling domestic wells. Although use of water for residential purposes "might" be limited, well logs on file at DGLS indicate that the shallow aquifer in the vicinity of the Weldon Spring site is or has been utilized as a private drinking water source. In addition, according to Section 1.1.2.2,

Page 1-11, Paragraph 2, "[I]n St. Charles County, the shallow and middle aquifers are also used, mainly for rural domestic water supply."

18. FS, Section 1.2.2, Groundwater, p. 1-18, Paragraph 1. The areal extent of TCE contamination at the site extends from east of Raffinate Pit 3 to the south and southeast of Raffinate Pit 4. Assuming that the raffinate pits are the source of the TCE, contamination has apparently flowed south, *toward* the groundwater divide (see Figure 3.7, Page 3-34). Please explain.

19. FS, Section 1.3.1.1, Exposure Scenarios, p. 1-20, Paragraph 4. According to this paragraph, because of the low transmissivity and low yield of the upper part of the shallow aquifer, a future resident would likely screen a private well in the deeper, more productive aquifers. While future residential wells are *likely* to be completed in the deeper, more productive aquifers, it is *possible* that some wells may also be completed in the shallow aquifer. The DGLS well log databases indicate that several private water wells in the vicinity of the site have been completed in the shallow aquifer. See Comment 17.

20. FS, Section 1.3.1.2 Risk Characterization, p. 1-21, Paragraph 2. The text states that the TCE-contaminated wells are "weathered wells." The *majority* of the TCE contamination has been detected in wells screened in the weathered bedrock unit. The wells themselves are not "weathered."

21. FS, Section 1.3.2.2 Results and Conclusions, p. 1-23, Paragraph 4. Because maximum contaminant concentrations reported from all springs were used to model contaminant uptake, the results are not specific to Burgermeister Spring.

22. FS, Section 1.5 Determination of Preliminary Remediation Goals for Groundwater at the WSCP and the WSOW, p. 1-26, Paragraph 3. According to this paragraph, the EPA published a proposed rule that set an MCL of 20 μg/L for uranium. The proposed MCL reportedly corresponds to 14 pCi/L for the activity concentration ratio of uranium isotopes found in groundwater at the WSCP. The paragraph goes on to state that a concentration of 30 μg/L for uranium in groundwater at inactive uranium-processing sites, which has been promulgated as a final rule, is a relevant and appropriate requirement and, accordingly, has been used in this FS as the PRG for uranium. Please provide the corresponding activity concentration ratio for uranium isotopes at the WSCP and the WSOW.

23. FS, Table 1.2 Summary of Regulatory Criteria and Risk-Based Values for Groundwater Contaminants of Concern, p. 1-29. According to this table, the regulatory criteria for uranium in groundwater is 30 *pCi/L*. However, according to information presented in

Paragraph 3, p. 1-26, the PRG for uranium in groundwater at this site is *30 μg/L*. Please clarify.

24. FS, Section 2.2 Technology Identification and Screening, p. 2-2. Several general response actions to address elevated concentrations of TCE at the WSCP have reportedly been identified. It should be noted that TCE has been detected in the groundwater at both the WSCP and the WSTA (MWS-21). In addition, the "Sampling Plan for the RI/FS for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri, Addendum 3: Soil Gas Sampling and Analysis for TCE at the Chemical Plant Area, Rev. 1" (June 1997) described characterization of TCE-contaminated areas outside the WSCP boundaries.

25. FS, Section 2.2 Technology Identification and Screening, p. 2-2. General Response Action 5 includes "storage" of extracted groundwater. Please elaborate.

26. FS, Table 2.1 Summary of Screening Analysis for Institutional Controls, p. 2-4. The suggestion of the use of well caps under groundwater access restrictions/effectiveness suggests the possibility of drinking water wells in highly contaminated areas. Please explain. See Comments 17 and 19.

27. FS, Section 2.2.2 Natural Attenuation, p. 2-7, Paragraph 2. According to the fourth sentence of this paragraph, "Biological degradation of the nitroaromatic compounds could be occurring at the WSCP and WSOW, *but toxic shock occurs at higher concentrations, relegating any biological activity to the fringe areas where concentrations are lower.*" However, the next sentence indicates that "Concentrations of nitroaromatic compounds in groundwater at the WSCP and WSOW are not expected to be high enough to cause toxic shock for most microorganisms capable of degrading nitroaromatic compounds." These two statements seem to contradict one another. Please indicate whether nitroaromatic concentrations at the WSCP and WSOW are expected to be high enough to cause toxic shock.

28. FS, Section 2.2.4.1 Bioremediation, p. 2-12, Paragraph 2. In-situ biodegradation of nitroaromatic compounds may reportedly result in the mobility of intermediates. Because biodegradation is one of the factors involved in natural attenuation, it seems that the mobility of intermediates might also be a concern associated with that technology.

29. FS, Section 2.2.2.4 Air Stripping, p. 2-14, Paragraph 1 and P. 2-15, Paragraph 2. In-situ air stripping is presented as a potential technology for the removal of TCE from the groundwater at the WSCP. It should be noted that TCE has also been detected in the groundwater at the WSTA. See Comment 24.

30. FS, Section 2.2.4.5, Fenton-Like Reagents, p. 2-15, Paragraph 1. Fenton-like reagents are presented as potential technologies for the removal of TCE from the groundwater at the WSCP. It should be noted that TCE has also been detected in the groundwater at the WSTA. See Comment 24.

31. FS, Section 2.2.4.5, Fenton-Like Reagents, p. 2-15, paragraph 1. One of the stated advantages of using Fenton-like reagents in the remediation of TCE-contaminated groundwater is the potential for full mineralization of the TCE to form oxygen and carbon dioxide. Chloride would also be expected to be produced. Please explain why chloride has been omitted from the list of resultant products.

32. FS, Section 2.2.4.5, Fenton-Like Reagents, p. 2-16, Paragraph 1. One of the stated advantages of using Fenton-like reagents in the remediation of TCE-contaminated groundwater is the ability of the H_2O_2 to follow the TCE in the aquifer. This implies that it is the H_2O_2 which reacts with the TCE; however, it is actually the hydroxyl radicals produced by the reaction between H_2O_2 and $FeSO_4$ (Fenton's reagent) that react with the TCE. Please clarify.

33. FS, Section 2.2.4.5, Fenton-Like Reagents, p. 2-16, Paragraph 3. The use of Fenton-like reagents was retained as potentially applicable to remediation of the TCE-contaminated groundwater at the WSCP. The use of Fenton-Like reagents for the remediation of TCE-contaminated groundwater at the WSTA should also be considered (see Comment 15). In addition, the applicability of this technology to the remediation of nitroaromatics-contaminated groundwater should be further investigated.

34. FS, Section 2.2.5.1, Vertical Wells, p. 2-17, Paragraph 5. According to this paragraph, the low permeability of the aquifer at the WSOW and most of the WSCP precludes the use of vertical extraction wells. It should, however, be noted that the TCE contaminant plume is reportedly located near one of the regions of highest permeability in the area (Page 2-15, Paragraph 2). Therefore, the use of vertical wells in this area may be feasible. See Comment 11.

35. FS, Table 2.3 Summary of Screening Analysis for Groundwater Removal, p. 2-19, Vertical Wells/Implementability. This table indicates that pump rates might be increased by fracturing of the bedrock. However, such fracturing is not recommended, according to Paragraph 2, p. 2-18.

36. FS, Section 2.2.7, Disposal, p. 2-15, Paragraph 1. An NPDES permit may be required to discharge treated groundwater to the Missouri River. The Department of Natural Resources, Division of Environmental Quality, Water Pollution Control Program should be contacted to determine if such a permit is required.

37. FS, Table 2.5, Screening of Potentially Applicable Technologies for Groundwater Remediation, p. 2-26, In-situ treatment/Fenton Oxidation/Comments. Fenton oxidation technology has been retained for limited use in the treatment of TCE contamination at the WSCP. See Comment 24.

38. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-6, Paragraph 1. Although it is true that the technical feasibility of complete removal of nitroaromatic compounds and uranium from the fractured shallow aquifer at the WSCP is uncertain, it should be noted that high levels of uranium were detected in in-situ groundwater samples above the bedrock along the Southeast Drainage.

39. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-6, Bullet 1. One of the factors to be considered in determining whether a site is a candidate for a technical impracticability waiver is "large volume, long duration release." According to this bullet, "The area over which groundwater contamination is estimated to exist is about 1,600 ha (3,900 acres) for the WSOW." While this may be a reasonable estimate of the total area affected by groundwater contamination, it should be noted that some of the contaminants (i.e., TCE, uranium, nitrates) are present in fairly localized areas. See Comment 11.

40. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-7, Bullet 1. One of the factors to be considered in determining whether a site is a candidate for a technical impracticability waiver is "contaminants low in volatility." According to this bullet, the vapor pressure of the contaminants of concern at both the WSCP and WSOW - which include nitroaromatic compounds, nitrates, and uranium - are all very low. It should be noted that the volatility of TCE, which is also present in the groundwater at the site, is very high.

41. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-7, Bullet 2. One of the factors to be considered in determining whether a site is a candidate for a technical impracticability waiver is "large volume of contaminated media." According to this bullet, "The volume of aquifer that might be potentially contaminated is very large, about 140 million m^3 (5 billion ft^3) at the WSOW and about 4 million m^3 (130 million ft^3) at the WSCP. While this may be a reasonable estimate of the total volume of the aquifer affected by groundwater contamination, it should be noted that some of the contaminants (i.e., TCE, uranium, nitrates) are present in fairly localized areas. See Comment 11.

42. FS, Section 3.3.2.2., Alternative 2: Monitoring with No Active Remediation, p. 3-9, Paragraph 1. The claim is made that the WSCP and WSOW may be good candidates for a technical impracticability waiver. Although this *may* be true for nitroaromatics contamination, a technical impracticability waiver may not be appropriate for TCE,

uranium, and nitrate contamination, which occurs in localized areas of relatively high permeability. See Comments 2 and 25.

43. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-10, Paragraph 3. According to this paragraph, Alternative 2 would involve the tracking of contaminant migration and degradation to "verify that the assumptions that potential drinking water supplies would remain protected." This statement seems to imply that the shallow aquifer is a potential drinking water source. See Comments 17, 19, and 26.

44. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-10, Paragraph 5 to p. 3-11, Paragraph 1. Institutional controls that *might* be applied for the WSCP and WSOW groundwater include land-use restrictions and continued federal ownership. Land-use restrictions *could* include St. Charles County zoning regulations and deed restrictions by the Missouri Department of Conservation on land not currently under federal ownership. The likelihood that such deed restrictions will, in fact, be placed should be fully investigated prior to selection and implementation of Alternative 2. See Comment 17.

45. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-11, Paragraph 3. Under Alternative 2, the groundwater monitoring plan would be reviewed every 5 years. At the end of the 5-year period, wells that duplicated information (e.g., wells located less than 15 m [50 ft] apart within the same aquifer and screened over the same interval might be considered for elimination. DGLS believes that wells which truly provide duplicate information should not be included in the initial groundwater monitoring plan for Alternative 2.

46. FS, Section 3.3.2.2, Alternative 2: Monitoring with No Active Remediation, p. 3-11, Paragraph 3. Under Alternative 2, response measures *might* be considered if future migration of contamination would result in unacceptable off-site exposure. Please describe what response measures *might* be considered. In addition, please describe the circumstances under which response measures would *not* be considered if future migration of contamination results in unacceptable off-site exposure.

47. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, p. 3-12, Bullet 6. According to this bullet, the most mobile and toxic organic compounds are usually the most susceptible to biodegradation. It should be noted that, at very high concentrations, biodegradation of organic compounds is inhibited, due to toxic shock. See Comment 27.

48. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, p. 3-13, Bullet 1. Groundwater that is naturally unsuitable for consumption includes groundwater that is not available in sufficient quantity at any depth to meet the needs of an average household. Although test

results suggest a low pumping rate for the shallow bedrock aquifer in the vicinity of the site, it should be noted that many private wells existed at the site prior to establishment of the Ordnance Works. In addition, there are currently private wells located outside the boundaries of WSOW which obtain domestic water supplies from the shallow aquifer. See Comments 17, 19, 26, and 43.

49. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, P. 3-13, Bullet 2. According to the text, none of the contaminants are highly volatile. See Comment 40.

50. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, P. 3-14, Bullet 3. The projected demand on the groundwater within the shallow aquifer is expected to be low, based in part on low pumping yield, which is reportedly about 1.2 L/min (0.3 gpm) "for a single well." Please indicate to which "single well" this statement refers. (A pumping rate of 0.3 gpm was utilized in the Appendix G calculations to determine the number of extraction wells required. Such calculations should utilize location-specific values for pumping rates.)

51. FS, Table 3.1, Analytical Parameters that Provide Information on Natural Attenuation of Chlorinated Aliphatic Hydrocarbons, p. 3-16. If possible, please provide similar tables illustrating the analytical parameters that provide information on natural attenuation of nitroaromatics, nitrates, and uranium.

52. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, p. 3-16, Paragraph 2. Additional monitoring wells might be installed and sampled to evaluate the protectiveness of Alternative 3 and to detect migration of contaminated groundwater. These wells are to be placed approximately 150 m (500 ft) downgradient of the leading edge of the contaminated groundwater or at the distance estimated to be traveled by the groundwater in 2 years, whichever is *greater*. Please explain why the *greater*, rather than the *lesser* distance was chosen for placement of the wells.

53. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, p. 3-17, Paragraph 2. Under Alternative 3, the groundwater monitoring plan would be reviewed every 5 years. At the end of the 5-year period, wells that duplicated information (e.g., wells located less than 15 m [50 ft] apart within the same aquifer and screened over the same interval might be considered for elimination. See Comment 45.

54. FS, Section 3.3.2.3, Alternative 3: Natural Attenuation, p. 3-17, Paragraph 3. Under Alternative 3, active response measure would be *considered* if future migration of contaminants would result in unacceptable exposure concentrations. See Comment 46.

55. FS, Section 3.3.2.4, Alternative 4: Groundwater Removal, On-site Treatment Using Granular Activated Carbon, p. 3-18, Paragraph 2. Groundwater extraction wells used in

aquifer remediation are typically located near the area of highest contaminant concentrations or near the leading edge of the plume. According to the text, "If placed in the area of highest contamination, the groundwater withdrawal typically intercepts the downgradient extent of the contaminant plume." It should be noted that the ability of a groundwater extraction system to intercept the leading edge of a plume depends upon several factors, including the number of wells in the extraction system, the zones of capture of those wells, and the distance from the wells to the edge of the plume.

56. FS, Section 3.3.2.4, Alternative 4: Groundwater Removal, On-site Treatment Using Granular Activated Carbon, p. 3-18, Paragraph 3. This paragraph mentions the potential for the air rotary method of drilling to result in vertical fracturing of the shallow aquifer. Please elaborate.

57. FS, Section 3.3.2.4, Alternative 4: Groundwater Removal, On-site Treatment Using Granular Activated Carbon, p. 3-18, Paragraph 3. According to this paragraph, the monitoring well screen, riser, and caps will be decontaminated *after* each well installation. Please explain why well construction materials are to be decontaminated *after* the wells have been constructed.

58. FS, Section 3.3.2.7, Alternative 7: In-Situ Treatment of TCE Using Electrokinetics, p. 3-31, Paragraph 1. The statement is made that "Currently available remediation technologies, such as 'pump and treat,' might not be completely effective in removing TCE from the contaminated area." Please describe the relative efficiency of electrokinetics in the removal of TCE from groundwater.

59. FS, Section 3.3.2.8, Alternative 8: In-situ Treatment of TCE Using Fenton-like Reagents, P. 3-37, Paragraph 3. Injection of aqueous solutions of hydrogen peroxide, ferrous sulfate, and other chemicals may require an Underground Injection Control (UIC) permit. These permits are issued by the Department of Natural Resources, Division of Environmental Quality, Water Pollution Control Program.

60. FS, Section 3.5.2.1, Effectiveness, p. 3-41, Paragraph 1. Under Alternative 2, response measures should be *considered* if future migration of residual contamination would result in unacceptable exposure concentrations at potential locations of existing or foreseeable receptors. See Comment 46.

61. FS, Section 3.5.2.1, Effectiveness, p. 3-41, Paragraph 4. Deed restrictions *could be* used to prevent the installation of new wells in the area of contaminated groundwater, thereby reducing the potential risk to human health associated with ingestion or inhalation of groundwater contaminants by limiting exposure. Continued federal ownership would

eliminate the potential risks associated with on-property groundwater but not those associated with off-property groundwater. See Comments 17, 19, 26, and 43.

62. FS, Section 3.5.2.2, Implementability, p. 3-43, Paragraph 2. According to this paragraph, no permits or licenses would be required to implement Alternative 2. However, Alternative 2 includes a provision for the construction of additional monitoring wells. It should be noted that the Missouri Well Construction Rules require that all monitoring wells greater than 10 feet in depth be installed by a Missouri-permitted well driller. In addition, registration of the wells is also required.

63. FS, Section 3.5.3.1, Effectiveness, p. 3-45, Paragraph 1. Deed restrictions *could* be used to ensure that no new wells would be installed in the area of contaminated groundwater, thereby reducing the potential risk to human health associated with ingestion or inhalation of groundwater contaminants by limiting exposure. Continued federal ownership would reduce the potential risks associated with on-property groundwater but not those associated with off-property groundwater. See Comments 17, 19, 26, and 43.

64. FS, Section 3.5.3.2, Implementability, p. 3-47, Paragraph 1. According to this paragraph, no permits or licenses for on-site activities would be required to implement Alternative 3. However, Alternative 3 includes a provision for the construction of additional monitoring wells. It should be noted that the Missouri Well Construction Rules require that all monitoring wells greater than 10 feet in depth be installed by a Missouri-permitted well driller. In addition, registration of the wells is also required.

65. FS, Section 3.5.4.2, Implementability, p. 3-49, Paragraph 4. The generation of substantial amounts of secondary wastewater is listed as one of the implementability issues associated with conventional groundwater extraction. Please describe what is meant by "secondary wastewater."

66. FS, Section 3.5.4.2, Implementability, p. 3-49, Paragraph 4 to p. 3-50, Paragraph 1. Potential negative impact on local groundwater resources (due to the depletion of the aquifer) is listed as one of the implementability issues associated with conventional groundwater extraction. See Comments 17, 19, 26, and 43.

67. FS, Section 3.5.4.2, Implementability, p. 3-50, Paragraph 2. According to this paragraph, groundwater extraction might not be effective for aquifer restoration to ARARs for TCE. Please indicate which of the other alternatives employ technologies which *would* effectively restore the aquifer.

68. FS, Section 3.5.7.1, Effectiveness, p. 3-58, Paragraph 3. Under Alternative 7, active response measures would be *considered* if future migration of residual contaminants

would result in unacceptable exposure concentrations at potential locations of existing or foreseeable receptors. See Comment 46.

69. FS, Section 3.5.7.2, Implementability, p. 3-59, Paragraph 5. According to this paragraph, heterogeneities or anomalies, such as sea shells, might reduce removal efficiencies under Alternative 7. Please explain how sea shells, which are not expected to be encountered at this site, would interfere with the implementability of Alternative 7.

70. FS, Section 3.5.8.1, Effectiveness, p. 3-61, Paragraph 4. Over the long term, Alternative 8 would reportedly be protective of human health and the environment for groundwater contaminants other than TCE. Please explain how the in-situ treatment of TCE would be protect human health and the environment from uranium, nitrates, and nitroaromatics.

71. FS, Section 4.1.1, Overall Protection of Human Health and the Environment, p. 4-3, Paragraph 1. This section states that the no-action alternative might be adequately protective of human health and the environment over the long term. According to the text, the groundwater is not accessible and is not used at the sites. It should be noted that contaminated groundwater from the WSCP and the WSOW is potentially accessible to the public through springs in the Busch and Weldon Spring Wildlife Areas. In addition, private wells in the area draw water from the shallow bedrock aquifer. Furthermore, according to Page 4-4, Section 4.1.3.2, ". . . in the event that access and use of the contaminated groundwater did occur, exposure to current concentrations of the contaminants of concern could result in unacceptable risks to human health." See Comments 17, 19, 26, and 43.

72. FS, Section 4.2.1, Overall Protection of Human Health and the Environment, p. 4-8, Paragraph 1. Under Alternative 2, "potential" migration of the contamination toward the surface springs would reportedly be monitored. It should be noted that contamination has been detected at area springs for a number of years.

73. FS, Section 4.2.3, Long-Term Effectiveness, p. 4-9, Paragraph 1. The claim is made that, under current land-use conditions, groundwater is not used and therefore poses no imminent risk to human health or the environment. It should be noted that some off-site private drinking water wells are open to the shallow aquifer, and a few of these wells have been shown to contain elevated levels of site-related contaminants. See Comments 17, 19, 26, and 43.

74. FS, Section 4.2.3.2, Protection of the Public, p. 4-9, Paragraph 4. According to this paragraph, the pathway for exposure to groundwater contamination is not complete. See Comments 17, 19, 26, 43, 72, and 73.

75. FS, Section 4.2.4, Reduction of Toxicity, Mobility, and Volume through Treatment, p. 4-10, Paragraph 3. Although Alternative 2 does not involve treatment of the contaminated groundwater, the reduction of toxicity, mobility, and volume under this alternative should be addressed.

76. FS, Section 4.2.6, Implementability, p. 4-11, Paragraph 2. Alternative 2 calls for the monitoring of "potential" off-site contamination of groundwater. It should be noted that off-site contamination of groundwater has already occurred.

77. FS, Table 5.1, Comparative Analysis of Alternatives, p. 5-3, and Section 5.2.2, Reduction of Toxicity, Mobility or Volume through Treatment, p. 5-7, Paragraph 2. Although neither Alternative 1 nor Alternative 2 involve the treatment of contaminated groundwater, the reduction of toxicity, mobility, or volume should be addressed.

78. FS, Appendix A, Table A.1, Groundwater Operable Unit ARARs, p. A-11. The Missouri Well Construction Rules should be included as an ARAR, in the event that extraction wells and/or additional monitoring wells are constructed at the site.

79. FS, Appendix G, Section G.2.1. Volumetric Extraction Rate, p. G-5. One of the parameters necessary to determine the number of extraction wells required to remediate the site is the "volumetric extraction rate." Little site-specific information is available on the sustainable pumping rates for either the WSCP or the WSOW. Such site-specific information is required in order to accurately determine the number of extraction wells required. See Comment 50.

80. FS, Appendix G, Section G.2.3, Width of Contaminated Groundwater, p. G-6. One of the parameters necessary to determine the number of extraction wells required to remediate the site is the "width of the plume." Because no defined plumes occur at the WSCP or the WSOW, "capture-zone width" values for "hot spots" were utilized. Please explain how these capture-zone widths were calculated.

81. FS, Appendix G, Table G.1, Input Parameters and Calculated Number of Extraction Wells for Each of the Contaminated Areas at the WSQW and WSCP, p. G-8. It is recommended that the number of extraction wells required to remove TCE-contaminated groundwater in the vicinity of the raffinate pits also be calculated (i.e., calculation for well cluster containing wells MW-2037, MW-2038, MW-3002(?), MW-3008(?), MW-3010(?), MW-3022(?), MW-3024, and MW-3025). See Comments 11, 34, 39, 41, and 42.

82. PP, Section 2.2.1, Geology, p. 7, Paragraph 3. The text states that the subsurface locally consists of porous, *unlayered* clay/silt/sand deposits overlying bedrock. The unconsolidated materials overlying bedrock at the site are, in fact, stratified.

83. PP, Section 2.2.2, Hydrogeology, p. 9, Paragraph 1. Aquifers are defined here as "geological layers containing groundwater." This definition should be amended to indicate that aquifer are subsurface geologic units capable of producing water. (Aquitards also contain groundwater).

84. PP, Section 2.2.2, Hydrogeology, p. 10, Paragraph 1. The text states that, "The direction of groundwater flow in the drainages [south of the groundwater divide] is from the WSCP to the adjacent WSOW." Because diffuse groundwater flow also occurs south of the groundwater divide, it is recommended that this statement be amended to indicate that groundwater south of the groundwater flow divide at the WSCP flows south, toward the WSOW.

85. PP, Section 2.3.1, Groundwater, p. 11, Paragraph 5. According to this paragraph, the primary contaminants in groundwater are uranium, nitroaromatic compounds, nitrate, trichloroethylene, and 1,2-dichloroethylene. 1,2-dichloroethylene is not listed as one of the contaminants of concern in the FS. Please explain.

86. PP, Section 5.2.4, Reduction of Toxicity, Mobility, and Volume through Treatment, p. 28, Paragraph 1. This paragraph states that the reduction of toxicity, mobility, and volume through treatment is not an applicable consideration for either Alternative 1 or 2, because no treatment of the contaminated groundwater is provided by these alternatives. However, according to Section 5.2, Item 4 (Page 25), this evaluation criteria addresses the statutory preference for selecting alternatives that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances at a site and focuses on the extent to which this is achieved by the alternative. Therefore, the criteria should be evaluated regardless of whether the alternative involves treatment. See Comment 75.

87. All of the active groundwater remediation alternatives are eliminated with a justification stating that "restoration time frames are greater than 100 years." First, some of the releases occurred approximately 50 years ago and/or 40 years ago. A remediation time frame of less than 100 years for contamination that has been subsurface more than 50 years would be an unreasonable expectation in most cases. I do not find this justification persuasive. Second, the time frame for restoration is based on modeling and minimal data to support the modeling. Again, this is not persuasive.

88. EPA guidance regarding modeling and practicality of remediation can be found in the Technical Impracticability guidance and several other guidances. These guidance documents, as well as many professional publications, warn against using models to predict the performance of restoration efforts and subsequently using the results as a basis for not pursuing restoration. This is exactly the rationale proposed in this document, and as such it is unacceptable. In general, models are adequate to size pumping installations

(first iteration), space pumping locations (subsequent iterations), and support restoration design. It is not acceptable to use them alone for predicting success/failure of remediation, remediation time frames, or extent of capture. All of these items must be gauged with real field data from an actual restoration installation, even if it is a pilot project (as opposed to full-scale.)

89. The tone and position of this document focuses on an "all or nothing" approach. That is, the alternatives are eliminated unless they can completely restore the aquifer in short time frames, easily and simply. If not, the document reasons that the alternative is not feasible. No effort is made to identify positive steps that can be pursued to reduce contamination in the worst areas and hence reduce risk. No effort is made to approach clean-up goals because, they reason, the job can not be completed. This is, in essence, technical impracticability (TI). Basing TI on models and projections is not acceptable, technically or procedurally. Also, many of the potential factors affecting groundwater remediation in section 3.3.2.2 are mis-applied or poorly rationalized. This also leaves the impression that groundwater remediation has been summarily dismissed.

90. I would offer the following scenario as the type of thing that can be done to achieve positive steps towards site groundwater cleanup. Install a french drain/recovery trench in the worst TCE groundwater contamination. Include adequate instrumentation in adjacent materials (within bedrock and overburden) to demonstrate capture of contaminants and contaminated groundwater. Operate this system to recover as much contamination as possible from the "hottest" area. Data from the installation and operation can be used to design other "hotspot" recovery installations and perhaps even dissolved plume remediation. Such decisions would be based on these results, not models. I would certainly be willing to accept that cleanup to MCLs may not be possible, but not "a priori" or sans such site-specific operation data.

91. The document does not contain any summaries of data from the RI and very few numbers. Quantities are characterized as "low" or "higher" or "few" or similar vague qualitative descriptions. The document should be supported with numbers and tables and ranges and distributions. In short, supported with specifics. I am not asking for all the RI data to be reproduced here. But the data should have been reduced to summaries, contour maps, tabulations, ranges, etc. in the RI and such reduced data should be presented here.

92. Page 1-3, 1.1.1. This is not a technical comment, but I feel that acquiring a portion of the site through condemnation leaves DOE with a debt to the local residents that should make the effort to clean the site even more compelling.

93. Page 1-16, 1.1.2.5. The document states "County zoning requirements for future housing developments in the area around the WSCP and the WSOW preclude the need for well

water for residential use." This sentence is misleading. The following paragraph in the report summarizes recent trends in development and private well usage. There is no discussion of any zoning requirements. The use of the phrases "zoning requirements" and "precludes the need" implies that zoning prevents private wells. I do not believe that this is the case and the narrative does not support that assertion.

94. Page 1-17, 1.2.1. It is also possible that uranium was encountered in the boring above the screened interval in well MW-4024 and carried into the screened interval during drilling or completion. The disappearance of the higher level may reflect a limited amount of such "cross-contamination." If bentonite was the culprit, there should have also been a high pH, which should also have disappeared by now.

95. Page 1-17 and 1-18, 1.2.1. These descriptions of contaminant extent should be supported by iso-concentration maps for each contaminant and for each contaminated hydrostratigraphic unit. Please provide iso-concentration maps.

96. Page 1-24, 1.4. I do not believe this FS contains "sufficient information to support decisions in accordance with the integrated environmental compliance processes..." The information is not adequate to determine the efficacy of the various remedial alternatives which are dismissed summarily with little support.

97. Page 2-1, 2.1. It is my understanding that the cost effectiveness is not a primary selection criteria, according to guidance, and falls after the items "bulleted" here.

98. Page 2-4, Table 2.1. It is not appropriate to assume that the state will retain ownership of the wildlife areas or that other state agencies will not allow groundwater use.

99. Page 2-4, Table 2.1. I don't agree that the monitoring system can be characterized as extensive. When considering the hydrostratigraphy, land size, and extent of the current system I believe that the system is lacking. This would be readily apparent on the isoconcentration maps that are requested in a preceding comment.

100. Page 2-5, 2.2.2. I don't agree with the characterization of remaining contamination as "low levels." They are certainly lower than the material removed in the case of soils. However, the water values exceed drinking water standards to a degree which can not be characterized as "low." As discussed previously, specifics should be included instead of such qualitative statements.

101. Page 2-6, 2.2.2. Sorption will not occur to any significant extent between clays and TCE. Paragraph one here implies that clays and organic soil content will sorb organic contaminants and uranium. While this may be true for the nitroaromatics, I know that it is

not true for TCE (an organic). TCE will only sorb to the decaying plant material\organic portion of soils (which will only be in the "top soil."

102. Page 2-6, 2.2.2. I am not aware of any studies which have demonstrated biodegradation of TCE beyond vinyl chloride. That is, TCE anaerobically biodegrades to one of the DCE compounds and then to vinyl chloride. Vinyl chloride does not naturally anaerobically degrade with any known biota. The Leahy paper referenced here involves toluene oxidizing bacteria. The Hopkins paper discusses Phenol-utilizing microbes. I suspect that these microbes have to have toluene/phenols present (co-metabolites) also to degrade TCE, although I haven't read the papers. Co-metabolism is not natural attenuation, and such references do not belong in this section. Please remove them.

    Vinyl chloride has been shown in some lab experiments to be aerobically degraded by microbes. However, it is unlikely that both environments and both sets of microbes exist in the natural subsurface in a distribution to foster complete mineralization of TCE. I do not have access to any of the listed publications or the symposium paper. If any of these papers show the complete mineralization of TCE, I would appreciate a copy for review. However, if they all involve co-metabolism or addition of other materials, they do not address natural attenuation.

103. Page 2-8, 2.2.3. As discussed previously during DOE's presentation, groundwater pumping and injection are both containment technologies.

104. Page 2-8, 2.2.3.1. Are the most contaminated areas and those with contamination greater than 15 m located together? Is the high contamination located deep? Isoconcentration maps by stratigraphic interval would help make this clear, as requested in an earlier comment.

105. Page 2-15, 2.2.4.4. If the higher permeability materials are located with the TCE plume near the raffinate pits, as discussed here, then pump-and-treat may be a viable alternative for this area.

106. Page 2-18, 2.2.5.1. Fracture stimulation generally creates horizontal fractures in overburden or shallow sedimentary rocks because the overburden weight is low and sedimentary materials tend to part along depositional planes. However, any hydraulic fractures which extend to comparable natural fractures will cease to propagate (or slow propagation) because the natural fractures will dissipate the fracture pressure.

107. Page 2-18, 2.2.5.2. Directional drilling can be very difficult in fractured materials and especially areas with low-angle fractures. It becomes difficult to maintain drilling azimuth

and declination because the fractures tend to redirect the drilling effort. Larger diameter vertical wells can also benefit groundwater recovery.

108. Page 2-20, 2.2.5.3. Interceptor trenches will remove water from hydraulically- connected materials subtending their base. Flow net analyses will show this to be true, although counter-intuitive. Also, interceptor trenches are more likely to encounter vertical fractures due to their larger plan-view area. They will encounter more of the heavily weathered materials than the typical vertical well, also. Hence, yields may be greater than predicted by the pump tests previously conducted at this site.

Finally, it may be useful to use the trenches in the most contaminated areas, but not the entire plume. However, after installation of the first trench, the drawdown area of trench can be gauged with monitoring wells/piezometers. It may be possible to place trenches at intervals along a "barrier" or capture line at a spacing which allows capture between trenches. This design would be enabled by installing the first trench and using the results to design subsequent installations (which in turn may provide data for further installations) in an iterative approach.

109. Page 2-21, 2.2.6.2. Chemical destruction of TCE with ultraviolet light and peroxide can be accomplished without ozone. Ozone can cause significant operational problems. The water must be clarified by lowering the pH if iron oxides cloud the water. The result is complete destruction of the TCE, not merely transfer to another media (air, solid). This process has been used at the DOE Kansas City Plant with success. Destruction has been demonstrated to be complete. After initial difficulties with ozone, operation has been reliable.

110. Page 3-6, 3.3.2.2. Although a large volume of aquifer material is within the plume area, it is doubtful that large amounts of intergranular porosity have imbibed the contaminants. Most of the contaminants probably remain within the fractures and other secondary porosity. So the volume of <u>water</u> that is involved is probably small compared to the total volume and that water volume is interconnected and relatively permeable in some instances. This category is supposed to be the water volume, not the aquifer material as calculated here.

111. Page 3-8, 3.3.2.2. The contaminants are not located at great depth. It is unclear how the range in depth could complicate recovery using vertical wells. If the wells are typically pumped dry, there should be no problem with using screens which span the entire contaminated, saturated interval.

112. Page 3-8, 3.3.2.2. The continuity of the permeable units would be the significant element here. The absence of the lower permeability and less fractured unweathered unit would

not add any complexity. Similarly, flow systems dominated by secondary porosity can not really be characterized as heterogenous.

113. Page 3-8, 3.3.2.2. Guidance from EPA Region VII ("Ground Water Technical Impracticability Decision Making in Region 7") to the HWP indicates that "There are not any predetermined criteria that automatically activate a TI waiver. Conditions such as the existence of dense nonaqueous phase liquids (DNAPLs) and sites located in Karst areas have been used as examples of criteria that could trigger TI. Alternatively, sites with exclusively dissolved contaminants in the ground water, that are located in low conductivity soils or bedrock may be just as impracticable for attaining risk or health based contaminant concentrations. Each site must be evaluated on an individual basis." The inclusion of hydraulic conductivity less than .0001 cm/sec as a criteria is no different.

114. Page 3-9, 3.3.2.2. High temporal variation refers to changing characteristics of the flow regime through time or seasonally, not contrasts between different portions of the flow regime.

115. Page 3-9, 3.3.2.2. Long release duration is cited in the first paragraph following the bulleted material. This is not supported in the corresponding bullet and the operations of each activity that released contamination appear to have been short in duration.

116. Page 3-10, 3.3.2.2. The second paragraph here states: "Although exact mechanisms that are naturally occurring cannot be identified, these observations suggest that active remediation of groundwater might not be necessary." This sentence demonstrates that DOE does not know which plumes may have entered the capture area for the monitored springs and has not completed the conceptual model for each of the releases. TCE does not disappear with any natural processes. Dilution is generally an inadequate mechanism because TCE is a health threat at very low levels (MCL is 5 ppb) and a little TCE can contaminate a large amount of water. One gallon of TCE can contaminate two million gallons of water at 100 times the MCL. Dispersion is typically negligible.

117. Page 3-10, 3.3.2.2. Discussion here indicates that DOE anticipates that 10 years would be a reasonable monitoring period following the ROD and that 15 wells would be added. I would suggest that monitoring of a remedy which involves natural attenuation/dilution/dispersion should continue until it is clear that the contaminants have naturally declined to levels that do not imply risk. Or, alternately, until they discharge to the surface or surface water and that impact can be assessed. Wells would have to be added to track plume growth. The existing well system may not offer clean wells at the downgradient margin of each plume, so 15 additional wells may not be a conservative number. In fact, I would anticipate several multiples of 15 would be required when including the need to track plume growth.

118. Page 3-11, 3.3.2.2. In view of the many military base closings and relinquishing of federal lands in recent years, what makes DOE sure that the entire WSTA will remain federal lands?

119. Page 3-11, 3.3.2.2. The document states: "Response measures might be considered if future migration of contamination would result in unacceptable off-site exposure." If an alternative is selected which involves monitoring only, then absolute commitments to contingent actions must be included in the decision (ROD) documents.

120. Page 3-12, 3.3.2.3. The first bullet implies that TCE will mineralize to water through natural attenuation. I am not aware of any studies that demonstrate this occurrence. The earlier comments and the publications cited by DOE are not natural attenuation. The publications involve co-metabolites for TCE destruction, which are not naturally occurring and are contaminants themselves.

121. Page 3-12, 3.3.2.3. Contrary to the last bullet, there are many mobile and persistent toxic organic compounds that are not susceptible to natural biodegradation, notably TCE and other chlorinated solvents.

122. Page 3-14, 3.3.2.3. The cited low potential for exposure does not include the potential for exposure through springs or transfer to the Missouri River alluvium through the Southeast Drainage. The document does not include sufficient information to demonstrate that this will not occur in the future.

123. Page 3-15, 3.3.2.3. As discussed earlier, models are not acceptable justification for remedy selection. Further, the extent of groundwater contamination has not been fully documented. Subsurface residual TCE contamination would be considered a contaminant source area since dissolution from such material offers an ongoing source. The location and extent of TCE residuals would be very difficult to identify and quantify. I do not believe that real field values for porosity and grain-size distribution have been obtained yet. Field values for porosity in secondary porosity are highly problematic as is determination of preferential flow paths.

124. Page 3-18, 3.3.2.4. Regarding the third paragraph, I am not aware of any higher potential for fracturing when air rotary drilling is used. In fact, since air is compressible and water is nearly incompressible, developing energy adequate to lift the cuttings should be less likely to cause fractures with air rotary.

125. Page 3-18, 3.3.2.4. Is it necessary to design a treatment train for all contaminants? Are any of the plumes located separately from the others, such that water with a single type of

contaminant would be pumped out? Wouldn't it then be better to design a treatment train for that contaminant alone?